JLab Experiment E00-108

Duality in Meson Electroproduction

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At high enough energies asymptotic freedom dictates a theory of quarks and gluons. However, confinement guarantees the experimental observables to consist of hadrons. Quark-hadron duality suggests that certain hadronic cross sections at high enough energies, averaged over an appropriate energy range, coincide with the quark-gluon perturbative calculations. Thus, quark-hadron duality naturally reflects the transition between strongly-interacting matter and perturbative QCD. The phenomenon is quite general, and occurs in e.g. $e^+e^- \rightarrow$ hadrons, semi-leptonic decays of heavy quarks, and deep inelastic scattering. Although the concept has been known for about 30 years, a quantitative understanding of quark-hadron duality is still elusive.

Deep inelastic inclusive scattering shows that scaling at modest Q^2 and ν already arises from very few resonance channels. This is reflected by the striking agreement ($< 5\%$) between data in the nucleon resonance region and the deep inelastic ($W^2 > 4$ GeV^2) region for $Q^2 > 1$ (GeV/c)^2, known as Bloom-Gilman duality. Electron-hadron scattering allows for further investigation of quark-hadron duality by virtue of it's ability to select resonances, by tagging with either spin or flavor.

E00-108 studies if a similar quark-hadron duality phenomenon exists in semi-inclusive meson electroproduction. At asymptotic energies, the cross section factorizes into an electron-quark scattering part and a quark $\rightarrow$ meson fragmentation function. New evidence suggests that this factorization still holds at energies far lower than anticipated. E00-108 will use 6 GeV electrons to study the meson (pions, and, with reduced statistics, kaons) electroproduction cross section as a function of z, Bjorken x, and Q^2, off both proton and deuteron targets. Defining W' as the undetected mass (i.e. the mass recoiling against the emerging electron and the tagged meson), the first objective will be to see if the z dependence of the fragmentation functions obtained at low Q^2 and W'^2 average to the scaling curve obtained at high Q^2 and W'^2. Furthermore, the data can be used to test factorization. If factorization is found to hold, it can open up new lines of investigation into quark fragmentation and QCD at these kinematics.